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it may be important to be aware whether or not the retrieval system covers thesauruses, to which the entered keywords correspond.

For such reasons, it has often been difficult for a beginner to obtain intended information or distribution.

5 In addition, in such retrieval system, the obtained result is evaluated for the simple reason that the result matches a Boolean equation with specified keywords. That is, it is often occurred that the result happens to match with the specified keyword and, in reality, the obtained result disappointedly turned to be unwanted one. Interrupted with such inconveniences, it is not easy to
10 select much-needed information for an individual user from long lists of the obtained results in order of precedence.

Summary of the Invention

The present invention aims to quantify the degree of necessity for the
15 desired image to the user and provides the user with much-needed image in order of precedence.

The image retrieval apparatus of the present invention retrieves a desired image from a communication network or an information-storage medium, such as a magnetic recording medium and an optical recording
20 medium. The apparatus includes:

(1) menu entry section accepting multi-leveled retrieval requests for the keyword tagged to an image;

(2) retrieval section evaluating the degree of necessity for the desired image to the user, using at least the entered requests and the number of the
25 requests in the menu entry section; and

(3) image display section displaying the image based on the degree of necessity evaluated in the retrieval section.

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output section 5 outputs an obtained electronic image signal. In tag section 2, menu entry section 4 and image output section 5, display screens are used for inputting and displaying.

Image retrieval section 3:

5 (1) stores an electronic image signal and the tag signal from tag entry section 2 into a built-in hard disk;

(2) evaluates a necessity signal for each electronic image signal according to the tag signal, and the retrieval request signal entered via menu entry section 4; and

10 (3) outputs the electronic image signal to image output section 5 such that the image signal with a higher necessity signal comes first.

Image retrieval section 3 includes hard disk 32, entering/correcting section 31, rating section 33, sorter 34, and communicator 35.

15 Entering/correcting section 31 writes an electronic image signal and a tag signal into hard disk 32, which stores the both signals.

Rating section 33 evaluates a necessity signal indicating the degree of necessity for an image, using the retrieval request signal handed from menu entry section 4, and the tag signal tagging to each electronic image signal stored in hard disk 32.

20 Sorter 34 sorts the electronic image signals such that the image signal having a higher necessity signal comes first, and outputs the sorted signals to image output section 5. Communicator 35 searches, via network 36, an image from accumulated data in a communication network.

25 Now will be described the workings of such structured image retrieval apparatus.

When the user converts an image such as an illustration into an electronic image signal with scanner 1, the image signal is set on an address,

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provided a file name. Then the user starts up the browser installed in his/her PC and selects the image entry page by clicking to start up tag entry section 2. In response to the operation, the browser displays tag entry screen 21 shown in Fig. 2.

5 When the user selects NEW IMAGE ENTRY in the screen, tag entry section 2 consults entering/correcting section 31 the number which is newly assigned to the electronic image signal to be added. In the embodiment, the already stored image signals have serial numbers from 1, so that the number next to which is given to the previously added image signal will be assigned to
10 the image to be added.

Tag entry section 2 displays image number 26, electronic image signal 22, keywords 24, which are received from entering/correcting section 31, and virtual buttons 25 shown next to each keyword. Here, an original image signal is scaled down and displayed as electronic image signal 22.

15 The keywords are classified into some groups, for example, in Fig. 2, they are grouped by field, place, and scene. Each class has plural keywords.

The user can click on desired one of virtual buttons 25 in the screen to add a tag signal to the image signal to be entered.

When the user clicks on Confirmation button 23 in the screen, the image
20 signal is stored with the corresponding tag signal into hard disk 32 as a file addressable by a number.

Suppose that tag signal "T_m", which corresponds to the electronic image signal addressed by number "m", has classes in numbers of "N_c". Tag signal "T_m" can be expressed in vectors in numbers of "N_c".

25 Furthermore, suppose that class "c" has keywords in numbers of "K_c". In this case, each vector of tag signal "T_m" is expressed in "K_c"-dimensional vector, where suppose that the component corresponding to the keyword

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specified a tag is set to 1, while the component with no tag is set to 0.

For example, tag signal "Tm" is expressed as follows:

$$T_m(c = 1) = (0, 0, 1, 0, \dots, 0, 1)$$

$$T_m(c = 2) = (0, 1, 0, \dots, 0, 1)$$

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$$T_m(c = N_c) = (0, 0, 0, 1, 0, \dots, 0, 1)$$

When correcting the tag signal tagged to the entered image signal, the user starts up tag entry section 2 as in the case of the entry operation, then selects CORRECTION in the screen. In response to the selection, tag entry section 2 prompts for the assigned number to the electronic image signal stored in hard disk 32. According to the number entered by the user, tag entry section 2 reads, via entering/correcting section 31, the specified image signal with the tag signal and displays them. Then the user operates similarly to the entry operation as the entry operation described above and completes the correction of tag signals.

When searching an image, the user starts up the browser and selects the image retrieval page by clicking to start up menu entry section 4. When menu entry section 4 comes up, menu 310 shown in Fig. 3 appears.

Menu 310 contains a long list of keywords, indicators 330 graduated in multi level by which the importance of each keyword is indicated, and a pair of buttons for each keyword: one for increasing the level of the degree of the importance, the other for decreasing it. The user can set the degree of importance for each keyword: the degree of importance for a keyword is increased by clicking the level-up button on the right side to move the pointer of each indicator 330, while it is decreased by clicking the level-down button on the left side. Through such operation, the user enters a retrieval request signal to search a desired image then clicks on searching button 320. In response to the

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clicking, menu entry section 4 sends the entered retrieval request signal to rating section 33.

In the embodiment, suppose that retrieval request signal "C" has "Nc" classes and class "c" has "Kc" keywords. In this case, signal "C" can be expressed "Nc" vectors. Each vector of signal "C" is expressed in "Kc"-dimensional vector, where suppose that the component corresponding to the keyword specified a selection criteria, i.e., the "j"th keyword in class "c", is set to "q (c, j)" as the value indicated by the indicator, the rest of the components are set to 0. For example:

$$C(c=1) = (0, 0, q(1, 3), 0, \dots, 0, q(1, Kc))$$

$$C(c=2) = (q(2, 1), 0, 1, 0, \dots, 0, 0)$$

.....

$$C(c=Nc) = (0, 0, 0, q(Nc, 4), 0, \dots, 0, 0)$$

In the embodiment, it is effective such that the value "q (c, j)" accepts 0 or positive values. In addition to 0 and positive values, it is effective such that the value "q (c, j)" further accepts negative values, which clearly indicates a negative meaning against the importance for a keyword.

Received retrieval request signal "C", rating section 33 sequentially reads electronic image signal "Im" and tag signal "Tm", which are addressable by number "m", and evaluates necessity signal "Nm" for each vector of tag signal "Tm".

According to the embodiment, if there are few non-zero values in each component of request signal "C", the necessity signal of the image signal in which there are few non-zero values in tag signal's component is increased. On the other hand, if there are many non-zero values in each component of request signal "C", the necessity signal of the image signal in which there are many non-zero values in tag signal's component is increased. The definition is based

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on a tendency described below.

For example, assuming that the illustration, in which a doctor's upper body is sketched, is the one to be retrieved, the tag signal would be tagged to the keyword "doctor" only. On the other hand, when the illustration, in which many strollers in the park or many stores on the street, is desired, plural keywords, such as "homemaker", "children", and "shopping mall", are expected to have tag signals simultaneously.

In the embodiment, the necessity signal is employed such that the keywords belong to the same class are ORed, while the keywords between different classes are ANDed, where the AND and OR are logical operators.

Using tag signal "Tm" and retrieval request signal "C", necessity signal "TNm" for an electronic image signal is calculated by the expression below:

$$TNm = Nm(1) * Nm(2) * \dots * Nm(Nc).$$

"Nm(c)" indicates the degree of necessity for class "c" calculated by the expression below:

$$\begin{aligned} Nm(c) = & 0.5 * (1 + \tanh((\text{length}(c) - \text{offset}) / \text{defuse}) \\ & * (\tanh(\text{score}(c) / \text{length}(c)) + 1) \\ & + 0.5 * (1 - \tanh((\text{length}(c) - \text{offset}) / \text{defuse}) \\ & * (\tanh(\text{score}(c) / \text{length}(c)) * \text{imagelength}(m, c) + 1) \end{aligned}$$

Where,

"imagelength(c)" is determined by adding small numbers to the sum of each component of class "c" 's vector "Tm(c)" in tag signals in order to avoid the occurrence of division by 0;

"length(c)" is determined by adding small numbers to the number of non-zero component of class "c" 's vector "C(c)" in retrieval request signal "C" in order to avoid the occurrence of division by 0;

"score(c)" is the inner product of class "c" 's vector "Tm(c)" in tag

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signal "Tm" and, class "c" 's vector "C (c)" in retrieval request signal "C"; and both of "offset" and "defuse" are parameters.

The expression is made of two terms to evaluate the degree of necessity of the electronic image signal, that is:

5 1) the first term in which the electronic image signal with more tags has a higher degree of necessity.

 2) the second term in which the electronic image signal with fewer tags has a higher degree of necessity.

 Which term is mainly used for the calculation in the expression depends
10 on the number of non-zero components of the retrieval request signal with reference to the value of "offset", and the value of "defuse". In more detail, the contributions of the first term and second term depends on whether the number of non-zero components of the retrieval request signal is larger or smaller than the value of "offset". When number of non-zero components is close to the value
15 of "offset", the degrees of contribution to the calculation from the two terms above are determined by the value of "defuse". Then, which terms above mainly contribute to the calculation changes with rapidity determined by the value of "defuse" in the neighborhood of the point that the number of no-zero components equals the value of "offset", which is the turning point of the change.

20 In the embodiment, it is preferable to have the value of "offset" ranging from 3 to 6, and the value of "defuse" ranging from 2 to 4.

 In addition, it is effective that different classes may have different "offset"s and "defuse"s.

 It is also effective that necessity signal "TNm" is the sum of necessity
25 signal "Nm (c)" of each class, where each "Nm (c)" is modified by assigning a weight prior to being summed. When employing this way, it is preferable to assign more weights to an important class in the search.

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A) Rating section 33 sends number “m” which addresses an electronic image signal and, necessity signal “Nm” corresponding to the image signal to sorter 34. Received these signals, sorter 34 generates an output signal in which the image signals are sorted in order of decreasing the rating of necessity signal “Nm”, then transmits the output signal to image output section 5. In the embodiment, the output signal is a Hyper Text Markup Language (HTML)-written source. Received the output signal, image output section 5 displays it on the screen.

10 i) calculating the entered tags with the class neglected;
 ii) calculating the entered number of selection criteria with the class neglected; and
 iii) calculation in which the rating of a selection criteria, i.e., the indicator reading, is used to calculate the degree of necessity.

15 The notable point of the embodiment is in that a tendency often observed
in tagging to images is used for the calculation of the degree of necessity. For
example, assuming that an illustration is the desired one, in which a doctor's
upper body is sketched, the tag signal would be tagged to the keyword "doctor"
only. On the other hand, when the illustration, in which many strollers in the
20 park or many stores on the street, is desired, plural keywords, such as
"homemaker", "children", and "shopping mall", are expected to have tag signals
simultaneously.

The necessity calculation is not limited to the way described above as long as such tendency is effectively used.

25 Although the explanation using the apparatus shown in Fig. 1 is given above, it is not limited to, as long as a similar way is employed, to obtain good results.

As described above, the present invention:

- 1) provides multi-leveled necessity entry for keywords in the menu;
- 2) evaluates the user's necessity rating for an image based on at least the retrieval request inputs and the number of the inputs prior to the search process; then
- 3) outputs the retrieved images in order of precedence.

Through this process, much-needed images can be offered users, according to the degree of necessity.

In other words, it enables to provide an improved human-computer interface that searches much-needed images based on the multi-leveled retrieval request entered by users and outputs the retrieved images in order of precedence.

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